CHAPTER 4

ACTIVITIES

Resources, which were discussed in the previous chapter, provide the inputs for forest sector activities. In turn, these activities give rise to outputs, which are the subject of the next chapter. The purpose of this chapter is to describe the range of activities that take place and examine their characteristics. The activities are very varied. They create incomes, employment and trade, and contribute to the welfare of the community at global as well as national level. Over time, the activities alter and the balance between them changes as the sector develops.

Some forest sector activities are forest-based and are concerned directly with the protection and management of forest resources; others are focussed on the transformation and movement of forest products, after they leave the forests, en route to consumers. The first group — the *forestry* activities — are 'supply' oriented. The forests are the source of tangible and intangible output and benefit flows. Forest management activities are broadly aimed at maintaining these flows, to both consumers in particular and society in general, in the short and the long term. The second group consists of *industrial* activities which are 'demand' or consumer oriented. They aim to satisfy the needs of end-users by converting raw materials from the forest into more valuable or useful commodities and distributing them to the places where they are required.

Forestry activities serve two purposes: conservation and production. The conservation function is concerned with protecting forest resources and safeguarding their capacity to provide future output flows. Conservation provides a variety of intangible benefits which accrue directly to particular groups of people or the community-at-large, as e.g. the conservation of habitat for endangered species, which preserves biodiversity for everyone. The activities aimed at production provide tangible outputs, some of which are used in their natural state and pass directly to consumers, while others form the raw material inputs which support the sector's industrial activities. The direct outputs include poles, fuelwood, game animals, fruits, fungi, etc, which are taken, mainly by people living near the forests, for domestic use; the industrial inputs must be processed to varying degrees before being sold to consumers within the country or for export. Forest management is therefore concerned with multiple outputs, the problems of joint production, and the resolution of conflicting requirements.

The size and economic importance of the two groups of activities is very unequal. Forestry activities tend to be widely spread and their impact is less obvious. Industrial activities are more concentrated and account for most of the sector's contribution to gross national product (GNP), a large proportion of the employment generated and nearly all the trade in forest products. They are mostly based on wood and nearly all the available statistics refer to wood products; FAOs 'forest product' statistics in fact refer to timber. A comprehensive view of the sector is obtained by dividing it into parts or *subsectors*, based on the different kinds of activity concerned with wood production. Other types of product do not involve all subsectors and service outputs accrue directly to consumers.

The first section of this chapter provides a classification of forest sector activities, based on division into six subsectors. Each subsector performs a distinctive function and interacts with other subsectors. Using this scheme, the contributions to value added, employment, capital formation and foreign trade, that are generated by the sector, are described and discussed in subsequent sections.

4.1 SUBSECTORS

Six distinct types of activity take place in the forest sector. These were recognised and described in a classic study by Dwight Hair of the economic importance of timber in the United States, which was published in 1963[1]. However, the types he distinguished are not peculiar to that country or applicable only to timber-based activities; they can be easily adapted to provide a convenient framework for general use. Hair's classification has been modified to derive the following breakdown of the forest sector into six subsectors:-

1. **Forest management** — all activities concerned with protecting, conserving and managing forest resources.
2. **Harvesting** — felling, cutting, gathering, collecting, removing and transporting wood and other forest products from the forest to local delivery points.
3. **Primary processing** — the conversion of wood and other forest products from their natural state into basic manufactured products, such as lumber, veneers, boards, pulp & paper, turpentine, rosin and essential oils.
4. **Secondary manufacturing** — the reprocessing and further manufacture of outputs from primary processing to produce finished goods, such as furniture, containers and paper products.
5. **Construction** — the use and fabrication of timber and other forest products for buildings and other fixed structures.
6. **Distribution and trade** — the transportation, handling, marketing and trade in timber and other forest products at all stages after harvesting.

These subsectors represent stages in the flow of production, which extends from the seedling to the consumer. The subsectors follow in succession, although some kinds of product do not need to pass through all the stages. Sawn timber illustrates the sequence. It begins in the forest with the regeneration and growth of trees to maturity; this stage, which may take many years, is part of the forest management

subsector. The next stage — the harvesting subsector — includes felling the trees, extracting the logs and transporting them to convenient collecting points, ready for sawmilling. The primary processing stage then takes over and the logs are cut up to produce lumber. Some of the mill output is sold to the secondary manufacturing subsector, perhaps for joinery, the remainder going to the construction subsector, say for roofing timber or shuttering. The activities involved in selling, handling and transporting the sawn timber, form part of the distribution and trade subsector.

The whole sequence of subsectors is not required in other cases as Fig. 4.1 makes clear. For example, poles, firewood and bamboo are used directly by consumers, without any processing. Similarly, some sawn timber and plywood passes straight from the mill to end users, avoiding secondary manufacturing. Many non-wood commodities, such as grasses, game meat, flowers and fruit, are taken for local sale or domestic use by people living in the vicinity of the forest; little processing is involved. However, other non-wood forest products, including gums, resins and some medicinal plants do entail factory extraction, distillation or purification before sale. Each type of output follows a different succession of subsector activities, which is more complete for some outputs than others. Nevertheless, all the activities which take place in the forest sector, can be assigned to one or other of the subsectors. The classification is all-inclusive.

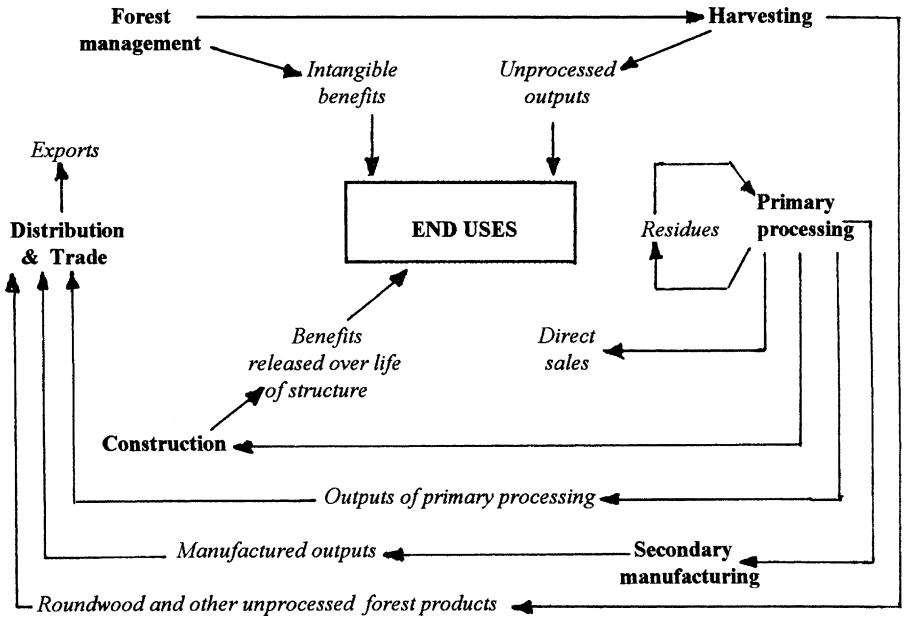

Figure 4.1 Subsector output flows

The sequence of subsectors follows the direction of flow of raw materials and outputs from subsector to subsector. During their progression along the processing chain, there is a reduction in bulk or weight. When logs are sawn or peeled, or sawn timber is machined, some of the wood is removed; part is unusable and goes to waste, the rest is sold or recycled as a by-product. In some cases, residues are passed directly to consumers, as with sawmill offcuts used for domestic fuel; other residues, such as the cores of peeled logs, may be utilised to produce sawn timber or woodchips for the manufacture of particle board or paper. Most of the raw material used by the primary processing subsector comes from harvesting, but some is derived from other processing activities which take place in the same subsector.

This classification into six subsectors has the advantage of being comprehensive, but the disadvantage of including some activities which overlap with other industries or sectors. The first three subsectors are obviously forest-based. Forest management and harvesting take place in the forest. Primary processing depends on raw materials obtained from forest resources and provides outputs which are generally described as 'forest products'. The difficulty comes with the secondary manufacturing and construction subsectors. These absorb large quantities of forest products, but also utilise products from other industries. For example, wood and wood panels are used in furniture manufacture, but metal items, plastics and textiles are also important furniture inputs; similarly, cement and bricks are essential building materials — they are even required for the foundations of wooden houses — and some forms of construction rely more for strength and durability on metal components than wood. A significant proportion of the output of both of these subsectors is not attributable to forest products, does not depend on forest resources, and therefore, should not be included in the output of the forest sector.

The parts of the forest sector which are wholly dependent on the forest, i.e. the first three subsectors, support a variety of activities which are also wholly dependent on forest resources. Secondary manufacturing and construction are partially dependent on forest products and these subsectors may include activities which use only small amounts of wood or other products derived from forest resources, compared with the larger quantities of inputs drawn from outside the forest sector. In some cases, when the forest-based input is relatively small, it becomes difficult to say precisely which activities should be included in these subsectors and exactly where the boundaries of the sector should be drawn. Therefore, to some extent, the sector's size and limits are a matter of judgement. However, in practice, if forest products are significant inputs, the secondary manufacturing activities which use them should be recognised as forest sector activities.

Table 4.1 indicates the wide variety of activities found in the forest sector. Some forest management activities are supportive and protective. They are concerned with the continued existence of forest ecosystems in the face of threats from agricultural settlement, fires, excessive grazing and unrestrained cutting. Other forestry activities provide tangible outputs and are aimed at production. Harvesting and the subsectors which follow, contain activities which are related to their outputs.

Table 4.1 Forest sector activities

Subsectors	Activities
Forest management	protection of forest land and ecosystems
	construction and maintenance of forest roads
	regeneration, cultural operations and tending of forest crops
	inventory, yield regulation and control of harvesting
	agroforestry and community forestry
	watershed management and soil conservation
	maintenance of landscape features and scenery
	wildlife and game management
	habitat and species conservation
	recreation management and tourism promotion
	safeguarding the basic needs of forest dwellers and rural populations
Harvesting	timber felling and crosscutting
	extraction of logs and other roundwood from forest to roadside
	collection and removal of leaves, flowers, fruit, and other non-wood products
	hunting or collecting animals, birds and insects
	transport of forest products to mills or other local delivery points
	extraction of water and minerals
Primary processing	preparation and treatment of poles and posts
	preparation of bamboos, canes and fibres
	production of woodchips
	sawmilling
	veneer, plywood and blockboard production
	manufacture of particle board, fibreboard and other board products
	manufacture of matches
	pulp and paper production
	processing of gums and resins
	extraction of essential oils
	preparation of drugs and medicinal products
Secondary manufacturing	machining, drying and further treatment of sawn timber
	joinery
	wood turning
	furniture manufacture
	paper and paperboard manufacture
	further processing of non-wood products
Construction	prefabricated timber housing
	building construction
	timber engineering
Distribution & trade	marketing of forest products
	storage and stock control
	transport of timber and other forest products
	merchandising and retailing
	importing, exporting and shipping
	international trade activities

Different processing and manufacturing methods, using different technologies, are used to produce different types of output. Thus, sawmilling requires machines and a workforce with the skills needed to cut up logs to produce sawn timber, plywood manufacture depends on 'slicing' or 'peeling' logs by rotating them against a knife and paper production is based on converting logs into woodchips and pulp by mechanical or chemical methods. Similarly, secondary manufacturing and construction activities are associated with the methods used. The kinds of activities involved in the distribution and trade subsector, such as marketing and transport, are generally comparable to those in other industries. They are functional, but differ in detail according to the nature of the product.

The list in Table 4.1 is intended show the range and diversity of the activities which take place in the forest sector, not to provide a comprehensive classification. Attempts at classification would require revision to keep up to date with changes in production methods and technology. Furthermore, each country displays a different assortment of activities — it has a distinctive forest sector profile of its own — which evolves year by year, as new industries start up, extra capital is made available and end users' requirements change.

As Box 4.1 illustrates, the very varied nature of these activities offers scope for specialisation by those who carry them out. A different person, agency or corporation, with appropriate expertise, frequently undertakes each stage, although some large corporations exhibit vertical integration and directly control all stages from the forest to the consumer. Except for these, the work in each subsector is done by different organizations, passing the output from one to the next, along the processing chain. As the output changes hands, ownership of the product is transferred from firm to firm. These transactions form the links in the chain and the value of the output exchanged at each stage builds up progressively as value is added to the product.

Sometimes individual enterprises or agencies undertake a range of activities which straddle subsectors. Thus government forest departments in some countries (e.g. India) not only manage forest resources but also undertake timber harvesting, and there are corporations (such as Weyerhauser) which control both forest resources and forest industries. The division into subsectors does not always correspond with the functions performed by organisations, although large-scale forest resources tend to be owned and managed by governments, while private sector companies concentrate on the processing and commercial activities associated with particular forest products.

Forest management activities involve distant time horizons because of the long periods required for growing trees to maturity — timber rotations in temperate zones frequently extend to 80 or 100 years. This is much longer than the time span required for industrial activities. Most harvesting is completed in days or possibly weeks; primary processing operations take a similar length of time. Investments in processing, such as sawmills or pulp and paper plants, usually have an economic life of no more than 20 years. Generally, the shorter perspectives of the industrial subsectors are better suited to a private enterprise approach.

Box 4.1 The history of a window frame

Six stages are involved, corresponding to the six subsectors, with six different types of organisation contributing to the process, as shown below. The forest owner is concerned with growing the timber crop from which the window frame is derived; at maturity, the trees are felled, the resulting logs are extracted from the forest and transported to mill by a logging contractor; there the sawmiller takes over and converts the round logs to sawn boards and scantlings; the rough timber then passes to a joinery manufacturer for resawing, machining and assembly into the finished window frame; the builders merchant holds the frame in stock in his warehouse before selling and delivering it to the building site; finally the window is installed in the completed house, which becomes the property of the new houseowner.

Forest management	*forest owner*	seedling ---------> mature tree
Harvesting	*logging contractor*	standing timber --> roundwood at mill
Primary processing	*sawmiller*	log ----------> lumber
Secondary manufacturing	*joinery manufacturer*	rough timber -------> finished frame
Distribution & trade	*builders merchant*	factory ----------> warehouse
Construction house.	*housing company*	building site ------> completed house

4.2 VALUE ADDED

Value is added to forest products as they move along the chain from forest to consumer. Seedlings cost a few cents, but grow into mature trees worth many dollars. The price of a standing tree (i.e. its 'stumpage' value) is much less than the value of the logs obtained from it. Sawn timber is worth several times the cost of the logs from which it was cut. The amounts paid for forest products of all descriptions, compared with the cost of the raw materials used to produce them, become progressively larger as additional value is generated by the activities in each subsector.

At each stage, raw materials and other inputs are used up and outputs are produced. There is a difference between the cost of the inputs and the value of the outputs; this difference is known to economists as *value added* (see Box 4.2). The total of the extra value generated by each of the activities in a subsector represents the value added by that subsector. Similarly, the sum of the additional value from all six subsectors amounts to the value added by the forest sector as a whole. This represents the contribution of the sector to the total annual output of the nation, i.e. the portion of the gross domestic product (GDP) that is derived from forest sector activities.

Box 4.2 Definition of value added

"Value added — the difference between the value of a firm's (or industry's) *output* (i.e. the total revenues received from selling that output) and the cost of the *inputs* of raw materials, components or services bought in to produce that output. 'Value added' is the value that a firm adds to its bought-in materials and services through its own production and marketing efforts within the firm."

Source: *Collins Dictionary of Economics*, 2nd. edition, 1993.

Value can be taken away instead of being added if the cost of the inputs exceeds the value of the output; value added can be negative as well as positive. This arises if operations are notprofitable or only become profitable because the prices paid for inputs or received for the output are distorted and do not reflect their true economic value. This situation may arise when governments intervene in markets or provide subsidies to promote particular activities. The attempts to encourage domestic processing of timber and discourage log exports in West Africa and Indonesia, which were referred to in the previous chapter, provide examples of resource misallocation with detrimental consequences for the forest sector in the countries concerned. Inefficient industries can, too easily, become a drain on the GDP.

The subsectors provide two kinds of output: intermediate and final. Intermediate outputs provide the raw materials used for further processing inside the forest sector, while final outputs are those products which are sold to end users or exported to other countries. Intermediate outputs form part of the inputs to other subsectors and are therefore excluded when subsector value added is calculated. Only the final outputs are included in the value added for the whole forest sector.

The forest sector value added is made up of the sum of all of its final outputs, after deducting the cost of raw materials and the value of any inputs that are obtained from other sectors . It is necessary to deduct the inputs from other sectors because they represent part of the output (and value added) attributable to those sectors and would therefore involve double counting if they were also included in the forest sector's output. For example, the cost of diesel fuel for logging vehicles, resins for bonding plywood and upholstery materials for furniture are all deductible items, which are the products of other sectors.

Another way to look at value added is the way that it is spent; it represents the amount available for payment of wages and salaries, interest, profits, taxes and depreciation. The forest sector contributes to the national output and also to the total income of the nation. Foreign transactions apart, output and income at national level are different sides of the same coin; the income is used to purchase the output. The value added by forest sector activities (after allowance has been made for depreciation and stock changes) indicates the contribution of the sector to the total income of the nation. At subsector and enterprise level, value added can be broken

down to show the amounts spent on payments to staff and labour, and the level of profits, as illustrated for logging activities in Trinidad in Box 4.3.

Value added calculations for the forest management subsector face a special difficulty. If the product approach is followed:-

> Value added = value of wood and non-wood forest outputs — cost of goods & services from other sectors.

The difficulty is that the value of the forestry output (and any surplus or profit) is not the result of only one years growth. In the case of timber, the value of standing trees at maturity has been built up, year by year, over a long period. It is unreasonable to attribute the whole of this accumulated value to the GDP of one particular year. A better measure of the output of the subsector would be the value of the annual increment, i.e. the additional value generated by new growth. However, this may not match the amount felled. The value of the output actually

Box 4.3 Harvesting in Trinidad

Logging in Trinidad in the 1960s was carried out entirely by numerous small-scale operators working on short-term licences. After felling, logs were usually crosscut and frequently roughly squared before extraction by bull or tractor to roadside, where they were sold to sawmillers who undertook their own transport to mill. Most of the work in the forest was subcontracted to others who were paid according to the task performed instead of daily wages. The value added by harvesting operations was estimated from a sample of more than 200 licences, taken in 1964, which showed the following average costs and returns (in West Indian cents per cubic foot of timber):-

Sale value of timber per cubic foot at roadside		**76 cents (100%)**
Royalty paid to Forest Department (stumpage)		9 cents (11.7%)
Value added		67 cents (88.3%)
made up as follows:-		
Wages paid to employees		5 cents (6.5%)
Payments to sub-contractors		31 cents (40.6%)
felling, cross cutting & squaring	8 cents (11.1%)	
loading	2 cents (2.1%)	
extraction	21 cents (27.4%)	
Licensees surplus		31 cents (41.2%)
licensees labour and animals	8 cents (10.0%)	
profit	23 cents (31.1%)	

Source: Gane (1966).

Box 4.4 The treatment of natural resources in national accounts

".....there is a dangerous asymmetry today in the way we measure, and hence, the way we think about, the value of natural resources. Man-made assets — buildings and equipment, for example, — are valued as productive capital, and are written off against the value of production as they depreciate. This recognizes that a consumption level maintained by drawing down the stock of capital exceeds the sustainable level of income. Natural resource assets are not so valued, and their loss entails no debit charge against current income that would account for the decrease in potential future production. A country could exhaust its mineral resources, cut down its forests, erode its soils, pollute its aquifers, and hunt its wildlife to extinction, but measured income would not be affected as these assets disappeared. Ironically, low-income countries, which are typically most dependent on natural resources for employment, revenues, and foreign exchange earnings are instructed to use a system for national accounting and macroeconomic analysis that almost completely ignores their principal assets."

Source: Repetto et al. (1989).

removed from the forest in any year may be more, or less, than the value of the new growth; it depends on circumstances and the decisions of forest managers. Only if the rate of removal matches the rate of replacement, does the output approach give a fair measure of the value added by forest management activities.

This difficulty can be avoided if the value of the output is adjusted to allow for changes in the value of the growing stock from year to year. However, this does not conform with the model system of national accounts published by the United Nations[2] and, consequently, it has not been customary practice to include forest inventory changes when national accounts are prepared. The problems associated with defining and valuing forest output were recognised some years ago by forest economists, including Kunnas[3]. More recently, the shortcomings of the present system of national accounts have attracted wider attention; the forest sector is not the only one affected when changes in the value of natural resource assets are omitted. Repetto et al. (see Box 4.4) have pointed out the serious consequences of treating natural resources as 'gifts of nature' and not allowing for either their depreciation as they are used up or their appreciation as they grow. This study[4], undertaken by the World Resources Institute, proposes a system of natural resource accounting, which is designed to correct the estimates of net national product and national income in national accounts. FAO has recommended a system of satellite accounts which would achieve the same purpose[5].

Corrections to the national accounts to allow for growing stock changes have been attempted in a number of countries with significant forest resources. In some cases this has been in response to the destruction of forest and other natural resource assets, which is taking place in some tropical countries such as Indonesia. The

recorded forest output in those countries overstates the sector's contribution to the national product unless an appropriate correction is made. While the GDP in Indonesia increased at 7.1 percent between 1971 and 1984, the true rate of growth of output, after accounting for consumption of natural capital, was only 4 percent according to the World Resources Institute study. In other countries the reverse occurs — the contribution to GDP is liable to be understated if new growth exceeds removals. This is the situation in Scandinavia, where the quantity of timber felled has been less than the volume increment over a number of years. It is also occuring in a few countries, such as New Zealand and Chile, where the forest sector is expanding due to rapid afforestation. New Zealand has adopted a system of forest resource accounting which indicates that changes in the value of the growing stock averaged about 1½ percent of GDP during 1989–93[6] (see Box 4.5).

Box 4.5 Allowance for forest stock changes in New Zealand

"In New Zealand, the rapid expansion of the exotic plantation estate from the 1960s was such that in 1978 it was decided to expand the coverage of the System of National Accounts (NZSNA) to incorporate the changes to the forest estate. Changes to the plantation estate have since been captured in the national accounts, along with changes to the livestock base in the agriculture sector. Based on these accounts, changes to the value of the plantation stock have contributed, on average, around 1.5 percent of total GDP over recent years. Changes to the value of the plantation stock have also made up about 25 percent of the total contribution of the forest sector to GDP."

	National Accounts Data ($ million)				
Year	Change in value of forestry stock	Contribution to GDP[1] Forestry & logging	Forest Sector[2]	GDP	Increase in forestry stocks as a % of GDP
1989	1092	1442	3884	66403	1.64
1990	1084	1538	4201	71435	1.52
1991	1075	1564	4244	73601	1.46
1992	1083	-	-	73378	1.48
1993	1165	-	-	77067	1.51

Notes: 1. Value added including changes in the value of stocks.
2. Includes Forestry & logging, manufacture of wood and paper products.

Source: Bigsby (1995).

National account adjustments have been taken further in Norway by attempting to include non-market goods and services[7]. The growing stock is increasing and

this is beneficial because it also involves additional carbon sequestration for which the forest acts as a 'sink'. It is argued that the resulting reduction in atmospheric carbon dioxide is equivalent to a reduction in the use of fossil fuels; this was valued by using the tax on petroleum fuel related to CO_2 emissions. The effect of this adjustment appears to be substantial: on timber sales of 3,371 million kroner in 1990, allowing for net growth of the forest stock added 522 million kroner (15%) and CO_2 fixation increased the value added by 1,925 million kroner (57%). The size of the increase depends on the method of valuation, however, and the adjustment might have been either larger or smaller than the estimate given if some other basis had been used. It is also worth noting that in other countries, where net losses in the growing stock are occuring, the value added should be reduced to compensate for the extra CO_2 released into the atmosphere. Adjustments to the accounts to allow for carbon sequestration in the forest, which are based on changes in the growing stock, do not tell the whole story, however. They assume that CO_2 is released as soon as the trees are felled, whereas if timber is removed from the forest and converted to sawn timber or other durable forms such as plywood, the release of the CO_2 contained in the processed wood will be delayed, often by many years.

These adjustments only apply to the value added by the forest management subsector. They are not applicable to the other subsectors concerned with harvesting, processing and subsequent activities, for which the value added calculations include adjustments for changes in stocks of wood products. As no adjustments for stock changes in the forest are made in most countries, statistics of the value added by forestry activities are liable to be misleading and less informative than the contributions recorded by other subsectors. However, the overall effect of such errors is less serious than might be thought. The value added by forest management is usually relatively small compared with the amounts generated by forest industries and, in relation to the contribution to GDP of the forest sector as a whole, the share provided by forestry activities is not very significant.

Perhaps the most striking feature of the value added by forest sector activities is the way that it builds up as forest products pass along the processing chain. Hair's groundbreaking study of timber-based activities in the USA illustrated this, as shown in Box 4.6. The forest management contribution was not adjusted for growing stock changes, but, even if it had been, the later stages would still have contributed far more than the subsectors at the start of the progression. A small amount of extra output from the forest leads to sequential value increases which multiply the economic impact many times before it reaches the consumer end of the chain.

Follow up studies in the USA[8] (USDA 1980 and 1982) shows that the forest sector's contribution to the national economy has altered over time and appears to be declining; the relative amounts coming from each of the subsectors is also changing. The value added attributed to timber increased from about $25 billion in 1958 to $48.5 billion in 1972. However, this increase was insufficient to keep pace with national economic growth over the same period, with the result that the timber-based contribution, as a proportion of GNP, declined from 5.6 to 4.1 percent; $1 out of every $18 of GNP came from timber in 1958, compared with $1 out of

Box 4.6 Value added attributed to timber in the USA, 1958

"The sum of the values added in all kinds of timber-based economic activities amounted to about $25 billion in 1958. This represented 5.6 percent of the Nation's gross national product — the market value of all goods and services produced. This means that about $1 out of every $18 of gross national product originated in some kind of timber-based economic activity.

Of the total value added attributed to timber in 1958 about 4 percent was added in forest management. An additional 6 percent was added in harvesting, 16 percent in primary manufacturing, 22 percent in secondary manufacturing, 31 percent in construction, and 21 percent in transportation and marketing.

Looked at another way these data show that in 1958 timber increased in value nearly 25 times between the stump and delivery of finished products to final consumers. On the average, to each $1 worth of stumpage cut another $1.50 was added in harvesting, $3.85 in primary manufacturing, $5.45 in secondary manufacturing, $7.60 in construction, and $5.35 in transportation and marketing."

Source: Hair (1963), page 5.

every $24 in 1972. The build up of value along the processing chain was also less pronounced. In 1958 timber increased in value nearly 25 times between the stump and delivery of the finished product to consumers, whereas the multiple had fallen to about 17 by 1972.

Although evidence is hard to come by because few comparable investigations have been carried out elsewhere, there is no reason to think that the progressive build up in value added in the USA is exceptional. A study of the forest sector in Trinidad[9] showed that in 1963, of the total value added by the first three subsectors (i.e. forest management, harvesting and primary processing), 8 percent came from forestry activities, 43 percent from harvesting and 49 percent from primary processing. In New Zealand, according to Bigsby, forest management + logging combined to provide 37 percent of the sector's adjusted contribution to GDP during 1989–1991. The build up is a general phenomenon, although the subsector percentages vary from country to country, depending on their particular circumstances.

Differences in the distribution of subsector activities between countries are inevitable, due to variations in their resource endowments and the stage of development reached. The nature of the forest affects the activities and the outputs. Countries such as Malaysia and Indonesia, which are rich in tropical rainforest, obtain a particular range of outputs from their forests and support forms of harvesting, processing and manufacturing which are adapted to that range and the prevailing climatic conditions. The balance of subsector activities in those countries is likely to be different to that found in countries with cooler or drier climates,

where the range of forest outputs is more resticted, and different technologies and working methods are used. Distinctive variations between countries also arise due to economic and social factors, such as population density, income per head, opportunities for trade with other countries, government regulation and the nature of the political system. These factors affect all aspects of national life and influence the path of forest sector development. As development proceeds, the processing chain tends to lengthen and the relative sizes of the subsector contributions alter; processing activities expand, manufacturing increases and a wider range of products is distributed to consumers.

The total value added in the forest sector, which depends on the size and range of subsector activities, varies from country to country. The sector's contribution, as a proportion of GDP, also varies between countries. Unfortunately, comparative data are not available. The few country analyses that have been published refer to different years and differ in scope. They provide few clues about the significance of the factors likely to influence sector size and importance. No general conclusions can be drawn about the sector's rate of growth or whether the relative size of its contribution to GDP is likely to expand or contract over time. It is obvious that during the course of development, the sector increases in size as more forest products are manufactured and the output flows become larger in quantity and value. What is lacking are insights into the necessary conditions for sector growth and the ways in which it can be promoted and sustained where this is desirable.

There is a dearth of information about the forest sector's role and economic contribution in different countries. In lieu of comparative value added statistics, the only surrogate that is available is provided by the figures of gross output of forest products published by FAO[10]. Although somewhat outdated, Table 4.2 gives an indication of the significance of the economic contribution resulting from forest sector activities. Usually, the value added by forest sector activities is less than the gross output, the difference being due to an unknown amount for goods and services purchased from elsewhere. However, the FAO figures exclude the economic contributions coming from secondary manufacturing, construction, distribution and trade; the omission of these subsectors is likely to affect the developing less than the developed nations. It is also possible that natural resource accounting and environmental adjustments, as described previously, would affect the positions of some countries in the table of comparative statistics.

The value of the world output of forest products in 1993 amounted to about 2 percent of the global GDP, according to the FAO statistics. Forest production in the developing countries accounted for about 3 percent, compared with 1 percent of GDP in the developed countries.This indicates the developing countries' greater dependency on primary production compared with the developed countries, where processing and manufacturing chains tend to be longer. Within both groups there are wide variations as can be seen in Table 4.2, although some care is necessary in interpreting them due to uneven reliability of the statistics. Some developed countries, which possess substantial forest resources, depend quite heavily on forest products, e.g. Finland (10%), Canada (6%) and New Zealand (6%); the value

Table 4.2 Forest sector production and trade in selected countries, 1993

Country or Region	Production *million $*	% of GDP	Imports *million $*	Exports *million $*	% of Trade	Consumption *million $*
Finland	9 230	10	475	7 411	32	2 294
United Kingdom	4 055	0	8 192	1 932	1	10 315
Germany	14 481	1	9 502	5 751	2	18 232
Spain	3 658	1	2 479	1 032	2	5 106
Europe	**75 235**	**1**	**47 141**	**41 427**	**3**	**80 950**
Former USSR	**18 443**	~	**124**	**2 061**	~	**16 506**
Canada	30 655	6	2 082	19 295	13	13 442
USA	93 189	2	16 873	13 401	3	96 661
North/Central America	**129 240**	**3**	**20 923**	**33 018**	**5**	**117 145**
Brazil	17 437	5	308	1 995	5	15 751
Chile	2 742	4	152	1 134	12	1 760
Guyana	6	1	2	6	1	2
South America	**25 421**	**3**	**1 639**	**3 532**	**4**	**23 528**
Bangladesh	1 424	4	26	0	0	1 450
India	16 543	4	262	17	0	16 788
Nepal	957	20	1	0	0	958
China	34 659	2	4 648	1 121	1	38 186
Indonesia	13 519	6	556	5 158	14	8 917
Japan	21 828	1	16 767	1 684	0	36 912
Asia	**111 899**	**3**	**33 701**	**15 203**	**2**	**130 396**
Australia	3 065	1	1 216	468	1	3 813
New Zealand	2 194	6	273	1 310	12	1 158
Papua New Guinea	460	8	5	464	19	1
Oceania	**5 814**	**2**	**1 541**	**2 350**	**4**	**5 005**
Senegal	188	3	13	0	0	201
Kenya	1 729	11	15	1	0	1 744
Nigeria	5 281	4	77	20	0	5 337
South Africa	2 079	2	327	566	2	1 840
Zaire	1 788	20	5	50	15	1 743
Africa	**25 276**	**3**	**1 672**	**2 027**	**2**	**24 921**
All Developed Countries	**246 834**	**1**	**85 325**	**80 232**	**3**	**251 926**
All Developing Countries	**144 493**	**3**	**21 417**	**19 386**	**3**	**146 524**
WORLD	**391 327**	**2**	**106 742**	**99618**	**3**	**146 524**

Source: FAO. *Forestry Statistics Today for Tomorrow*: 1945–1993…..2010

of forest production was only about 1 percent of GDP in other industrialized countries, including Germany and Japan. Amongst the developing nations, some of the poorest countries rely on their forests for fuel, as in Nepal (20%), while others with substantial forest resources, such as Zaire (20%), Papua New Guinea (8%) and Indonesia (6%), are exploiting them to generate trade.

Without comparative statistics of the forest sector's contribution to national product in different countries, which are repeated at intervals to show changes in

the value added, it is very difficult to draw general conclusions about its growth and development. The sector may grow faster or slower than the rest of the economy and its performance in relation to the growth and development of other sectors may also change. The value added by the forest sector obviously increases as its activities expand and national development proceeds, but how best to influence the growth process, ensure that it is sustainable and obtain the greatest national advantage from it, are questions that cannot at present be answered satisfactorily. Scarce resources, combined in various ways, can significantly alter the contributions generated in different parts of the sector. Historical studies of forest sector development, based on the structural and economic changes taking place, are necessary before any general conclusions can be drawn about the mechanisms involved.

4.3 EMPLOYMENT

Forest sector activities contribute value to the total production of the nation; part of that value added consists of payments made to human resources in the form of wages and salaries. When value is added, employment is also generated. The amount of employment — the number of jobs — depends on the scale of the activities and also on their nature. Some activities in the forest sector are highly labour intensive, including many forest management operations, while others are described as capital intensive and employ a few skilled workers to control very expensive plant and machinery, as with pulp and paper manufacture.

Like value added, employment in the forest sector tends to expand with movement along the processing chain. Hare's study for 1958 showed the relatively small contribution provided by forest management in the USA — only 3 percent of the total employment attributed to timber; for every person employed in forest management, 10 more were employed in logging and primary processing and 30 more in the subsequent subsectors. Evidence for other years in the USA (see Box 4.7) and from other countries supports this general pattern, although the percentages obviously vary according to local circumstances and the stage of development reached.

Historically, the share of total employment that is attributable to the forest sector has tended to decline through time. Forests are now relatively less important as a source of industrial raw materials than in the past and the use of wood for industrial and domestic fuel has been largely superseded by other forms of energy in most developed countries. At the same time, labour productivity has improved and forest operations have become more mechanised. Mather[11] cites the example of Canada, where almost half the adult male population was involved in the timber and lumber industry in the late nineteenth century, while only 7 percent of the labour force is forest-dependent now. In Sweden, forest sector employment reached a peak at the end of the 1930s, since when it has declined at a rate of about 2 percent per annum. In the USA, the employment attributed to timber fell from 5.6 percent of total employment in 1954 to 4.5 percent in 1963 and 4.0 percent in 1972.

Forest resources were often used recklessly in the early stages of development, particularly in countries where they appeared to be unlimited as in North America.

Box 4.7 Employment attributed to timber in the USA, 1972

"Employment (full-time equivalent) in all timber-based economic activities amounted to 3.3 million people in 1972. This represented about 4 percent of the total civilian employment in the United States in 1972 and means that about 1 out of every 25 persons employed was engaged in some type of timber-based economic activity. In 1963, the employment attributed to timber was 3.1 million, about 4.5 percent of total civilian employment.

Some 4 percent of the employment attributed to timber was in timber management, an additional 6 percent in harvesting, 13 percent in primary manufacturing, 27 percent in secondary manufacturing, 24 percent in construction, and 26 percent in transportation and marketing. These data on employment attributed to timber show that for each worker employed in forest management and harvesting, four were employed in primary and secondary manufacturing and five in construction, and transportation and marketing."

Source: USDA (1980), page 27.

Large tracts were cleared to make way for farms and the residual forests were mined rather than managed. As areas were worked out, logging and sawmilling operations were forced to move on and the labour force, housed in camps, migrated to fresh sites. This transient pattern of natural forest exploitation is being repeated today in many developing countries, where 'cut and run' logging is prevalent[12]. So long as the resource lasts, employment continues at an inflated and unsustainable level; when the saleable timber has been worked out, most of the labour force is paid off or relocated. Forest sector development which is based on unsustainable rates of resource utilisation, is liable to destabilize forest-dependent rural communities. In these circumstances the forest sector creates employment, but it is not necessarily permanent employment.

When sustained yield management is introduced, the flow of output from the forest is likely to be reduced, which at first leads to job losses in rural areas although it may help to stabilize employment levels later on. It may not always be welcomed by the local communities who are hardest hit and special measures to soften the social impact may be desirable. In some respects the introduction of yield restrictions in forests is comparable with stopping the overexploitation of fisheries resources when boats have to be laid up and fishermen are thrown out of work. If time is allowed for adjustment by progressively reducing the rate of felling (or the size of the catch) over several years, new employment opportunities can be created and the work force can be retrained. It is preferable to anticipate the conversion to sustainable rates of exploitation rather than wait until the damage to the resources becomes critical or even irreversible. Forests are generally more flexible than fisheries because it is often possible to create new forestry employment by investing in silvicultural operations which increase the productivity of existing

resources, establishing plantations or diversifying the range of outputs/benefits that the forests provide. There are many opportunities for creating employment in the forest sector which can be used to allay fears of job insecurity.

Instability is also caused by fluctuations in the demand for forest products, which lead to corresponding variations in forest sector activity. Even though population growth and rising incomes per head lead to ever larger requirements for forest products, the upward trend in demand is not constant; it tends to be cyclical with periods of rapid increase followed by downswings, as countries experience alternate periods of economic expansion and recession. These fluctuations, which originate in the global economy, affect forest sector employment nationally and the numbers working in harvesting, processing, manufacturing and construction at regional and local level. Their consequences are felt most in places where the economy is poorly diversified and there are few opportunities for alternative employment. Their impact is greatest in rural areas and developing countries.

In the past, the cyclical movements in economic activity were more pronounced, there were long periods of depression, and special measures were taken to relieve widespread unemployment, poverty and social distress. During the 'Great Depression' of the late 1920s and early 1930s, forestry programmes were used to provide relief work in a number of countries. Roads, firebreaks, towers, picnic facilities and similar capital improvements were constructed in the USA[13]. Reforestation was carried out in Britain and in New Zealand (see Box 4.8) extensive areas were planted with exotic conifers which became the basis for a further wave of planting and large-scale forest industry development after 1960[14].

Box 4.8 Afforestation in New Zealand

"Most of the forest areas were established during one of two boom periods; the late 1920s and early 1930s and from the late 1960s onwards. The first planting boom extended 12 years, and comprised a variety of species, notably Corsican pine, ponderosa pine, lodgepole pine, Douglas fir and radiata pine. The bulk of these older plantings occured in the central North Island and were initiated by Government as part of depression relief-work schemes, in response to the perceived possibility of timber shortages and as a means of using cobalt-deficient, pumice scrublands."

Source: Valentine (1993).

After the Second World War, attention turned to efforts to raise living standards in the 'underdeveloped' countries. The potential of the forest sector for generating jobs and income in these countries was recognised as Box 4.9 shows and attempts were made to exploit it, though not always with the hoped for results. Nevertheless, employment creation remains a national policy aim in many places and

Box 4.9 Labour absorption by the forest sector

"Forestry and forest industries provide many opportunities of absorbing under- and unemployed labour. Even in the developed countries almost all operations in the forest are carried out by manual labour. Afforestation, thinning, pruning, nursery work and some aspects of insect and fire control, for instance, do not lend themselves readily to mechanisation: these operations are mechanised but rarely, and only in those countries where labour is extremely scarce and expensive.The same is true for many aspects of forest exploitation — save in those instances where large log sizes compel mechanization. What should be emphasized here, however, is that limited or negligible mechanization should not imply primitive methods of work. In all these phases there is ample scope for spectacular increases in productivity by the provision of suitable transport and simple, well-adapted tools."

Source: Westoby (1987), pages 51–52.

the mobilization of underutilized labour resources is often seen as a development priority. It is generally believed that the forest sector can make a worthwhile contribution to the achievement of this aim[15] although estimates have sometimes been over-inflated as Box 4.11 shows.

The numbers employed in the forest sector depend on the level of activity. Employment tends to increase as the sector expands, other things being equal. The greater the flow of forest products from subsector to subsector, the higher the level of activity and the larger the workforce required. If there are deficiencies on the supply side or fluctuations in demand, the growth tendency may be checked in the way previously described, but the underlying upward secular trend continues, based on long term increases in the consumption of forest products by the general population. However, this trend is offset by an opposing downward tendency: employment tends to be reduced by technological progress and improvements in labour productivity. When fewer people are required to produce the same output, the growth of employment is held back. Which influence is strongest depends on circumstances and the balance between the tendencies may alter with time. Future employment expectations should be treated with caution; they have sometimes been inflated because changes in technology and productivity were overlooked.

4.4 CAPITAL FORMATION

Forest sector activities generate incomes and employment; they also contribute to the formation of additional capital resources, which increase the sector's capacity to provide future output, incomes and jobs. Most of the present income flows, which accrue to organisations and employees, are used up during production or consumed to meet day-to-day needs, but a smaller amount is saved and invested

Box 4.10 Overestimates of employment opportunities

"……there appears to be a widespread tendency to overestimate the number of jobs that forestry and forest-products industries can provide. Employment potential is frequently an important element in forest policies or in justifying individual projects, and exaggerated or over-optimistic estimates have often been made. For example, it was forecast in the early 1970s that employment in forestry and wood industry in Australia would rise substantially: in fact it has declined. In Scotland the chief minister in promoting a programme of forest expansion in the 1940s looked forward to a day when forestry would employ as many workers as agriculture and coal mining (around 15,000). In fact it now employs little more than 10,000,"

Source: Mather (1990), page 278.

to meet future requirements. This contributes to capital formation within the sector and may in some circumstances provide capital for other sectors, thereby adding to total national investment.

Some problems with the definition of capital in relation to resources were described in the last chapter. Two kinds of capital were distinguished: capital funds and capital goods. Our concern here is with the accumulation (or run down) of capital as a store of value. Activities in the forest sector enable its resource endowment to be built up by additions to the value of the natural, human and capital resources that are present. Capital funds provide a mechanism for mobility which enables investment (or disinvestment) to take place where it is required. Capital goods refers to the physical assets, such as factories and equipment, which are acquired as a result of investment. However, investment may also affect the sector's natural and human resources.

According to Clayton & Radcliffe, the word *capital* refers to human generated wealth, including both the goods that society produces and the tokens of value, such as money, that society uses to transfer wealth[16]. They separate *artificial* capital, which is used for the goods and services that society produces, from *natural* capital, which refers to those features of nature that are directly or indirectly utilised or are potentially utilisable in human, social and economic systems. Both kinds of capital are present in the forest sector, but natural capital is mainly found in the forest management subsector whereas artificial capital is spread throughout all subsectors. The natural capital of the forests, consisting of the trees, plants, wildlife and other living organisms that have acquired value because of their utility to man, may conveniently be called *forest capital*. This classification is useful because it points out that the value of natural capital results from its utility; therefore its value may alter if people are prepared to pay more (or less) for it, regardless of any investment that may take place in the forests. However, the terminology is somewhat misleading because managed natural forests and plantations are artificially created by society.

Forest capital is therefore a hybrid, partly formed by nature and partly as a result of investment by society.

The artificial capital that is used during manufacturing and distribution consists of buildings, machines, vehicles, equipment and other artifacts; less tangible features of the productive process, such as the capacity to provide services and a specialized knowledge base are also included. Some artificial capital is employed in forest management activities, but most is to be found in the industrial subsectors concerned with handling and processing the raw material outputs obtained from the forest. The most important factor which controls capital formation in these subsectors is therefore the capacity to cope with the quantity of material passing through them in response to market demand from consumers — an increase in the required 'throughput' will lead to extra capital formation, once the existing capacity is fully utilised. Thus, global consumption of paper and paperboard averaged 25 kg per head in 1960, rising to 38 kg in 1984 and 44 kg by 1995[17]; world capacity for manufacture of these products amounted to 220 million metric tons in 1985 and is expected to rise to 337 million metric tons by the year 2000[18].

Capital formation also occurs in response to changes in technology. This involves the substitution of less expensive or relatively abundant resources for more expensive or scarce resources, as for example the introduction of labour saving equipment in forestry and harvesting, and the replacement of circular saws by bandsaws to improve sawmill recovery rates. New technologies can create entire new industries, cause old products to be replaced by new ones, create new inputs or increase the productivity of old ones, and otherwise affect the processes by which goods and services are produced, distributed and consumed[19]. This is illustrated by the development of new board products, such as medium density fibreboard (MDF). Generally it is very difficult to identify and separate capital formation caused by the need to increase capacity from that due to technological change; often investments are undertaken with both objectives in mind and statistics do not distinguish between them.

Artificial capital is continually created by investment and used up through wear and tear. The investment may be provided from income and savings generated within the forest sector or new investment may come from outside. It is the normal practice of business enterprises to reflect the run down of capital assets by allowing for depreciation in their accounts; they are guided by the principle of keeping capital intact and make provision for the replacement of fixed assets at the end of their useful life. However, in practice, the replacements are seldom identical to the old assets and the opportunity is taken to re-equip with up-to-date machinery and the latest technology. Assets may even be written off ahead of time if the pace of change is rapid and they become technically obsolete; investment in new production methods then becomes essential to remain competitive. The forest sector's endowment with artificial capital resources is renewed and updated by this turnover of assets. Without the turnover, the sector's activities would soon cease to be sustainable. Therefore, it is necessary to maintain an investment flow which is at least equal to the rate of depreciation. The long-term survival of the sector depends

on preserving a balance between capital formation and capital depletion. Sector expansion and development involves additions to the stock of artificial capital.

There is a significant difference between the types of capital: artificial capital depreciates in use and gradually runs down in value unless provision is made for its replacement, whereas forest capital is capable of self-renewal through regeneration and growth. Left to themselves, trees do not depreciate or wear out; usually their value appreciates as they get older until they become over-mature. Capital formation takes place through the biological process of tree growth. Trees increase in size, year by year, until physical growth slows down and eventually ceases in old age. Their value for timber also tends to increase with size, because large logs usually fetch a higher price per m^3 than small ones — sawmill wastage is lower and timber quality is higher. Ecosystem enrichment may also occur because older tree communities tend to support a greater diversity of associated species than is found among seedlings and saplings.

Forest crops consisting of trees of similar age, increase in volume and value as they grow; forest capital in the form of standing timber accumulates until the trees are felled. The longer that even-aged crops (such as plantations) are left to grow, i.e. the greater the rotation, the more the value of the growing stock, although the rate of capital accumulation slows down in later life. The capital value of uneven-aged crops (as in natural forest) depends on the distribution of size classes of the trees, but also tends to increase as the trees get older; a given area of forest may support a larger or smaller growing stock, depending on the species present, their growth rates and the way the crop is managed. Whether the crop is even- or uneven-aged, the amount of the growing stock and therefore the capital value of the forest depends on the age of the trees and is influenced by the management regime.

Management for sustained yield depends on maintaining a balanced succession of age classes, leading up to the oldest, and harvesting the age classes in turn. Within limits, the capital value of the forest can be altered by adjusting felling rates and changing the rotation or felling cycle while still preserving the continuity of the output flow. Longer rotations generally support a higher capital value per ha than shorter rotations and forest capital can be built up by slowing down the rate of felling and removal; conversely, a higher removal rate tends to reduce forest capital. The principle of maintaining capital intact, which applies to artificial capital, involving the preservation of a balance between the depletion and renewal of assets, is also applicable to forest capital. Normally, the rate at which forest products are removed should match the rate at which they are replaced by new growth. This *growing stock balance* is a useful indicator of sustainability. However, it is not an infallible guide because a management regime, which involves felling large, slow-growing, overmature trees in order to replace them with a young, quick-growing crop, may sometimes justify harvesting at a faster rate. It may also conceal ecological deterioration or other adverse environmental effects which alter the capital value of the forest.

If the balance is upset by excessive rates of exploitation, future productivity may be undermined. In extreme cases the forest resource may be degraded by

uncontrolled cutting and grazing or destroyed by forest clearance. The capacity of the forest to sustain the output flows to other subsectors will then be affected and the flows may even cease altogether. This will have a knock-on effect on the ability of the forest industries to continue to generate income, savings and investment. In the long run, the viability of the whole forest sector depends on the way the forests are managed; sustainable forestry is a prerequisite for a sustainable sector. If the forest capital is dissipated, the sector's capacity to replace its artificial capital will also eventually come to an end; both forms of capital are interdependent.

Historically, in several countries, the exploitation of untapped forest resources in their natural state has contributed to capital formation outside the sector and accelerated national development. In the USA and Canada, during the second half of the nineteenth and the first part of the twentieth century, their rich forest endowments were used to generate other forms of capital for the advancement of agriculture, mining, the construction industry, communications and manufacturing[20] (see Box 4.11). Rostow records the substantial increases in savings and investment rates that marked the 'take-off' stage in national economic development in these and other countries[21]. Profits from timber were ploughed back to create productive capacity in other sectors, often indirectly through the medium of foreign trade; timber contributed to a rapid rise in exports, which was used to finance imports of capital equipment and service the foreign debt. Wealth flowed out of the forest sector, pushing up investment and stimulating rapid growth.

Box 4.11 Transformation of forest capital in the USA

"The USA's deforestation was not a deliberate strategy to produce national wealth, but was an inevitable consequence of making room for agricultural expansion. Stocks of timber were converted into liquid capital, yielding arable land beneath them as an even greater source of national wealth. Previously unproductive forest assets produced an injection of housing materials, railroad ties, mine timbers, and other products for industry and household consumption. The newly converted lands under agriculture provided an increased flow of food products for both subsistence and market sales, helping propel the countries industrial urbanization. Forest conversion financed much of the USA's early economic development".

Source: Laarman & Sedjo (1992), pages 106–7.

Although forest resources were liquidated to provide funds for non-forest purposes in the past, present-day repetition of the process is subject to severe criticism and countries where it is being allowed to happen, even on a limited scale, face the prospect of international disapproval. Forests, after unrestricted exploitation, cannot continue to yield a steady flow of outputs for processing and consumption or the same range of intangible benefits for the community; the consequences

are obviously unsustainable and it is no longer acceptable to generate capital for development in such a destructive way. Those countries, particularly in the tropics, which continue to deplete the capital stock locked up in their forests for short-term commercial gain, would benefit if they adopted sustainable resource management practices. They would avoid much of the outcry from conservation activists but, more importantly, by maintaining the viability of the resource base, could sustain the income flows on which capital formation depends. Capital conversion could still take place, although at a rather slower pace.

Forest capital can be readily converted to artificial capital, but the reverse process is very difficult, often impossible, and involves waiting a long time for the trees to grow. The creation of forest capital depends on patience; the rate of formation is limited by the natural growth rate of the trees and there is a long interval between regeneration and harvesting. Waiting has an opportunity cost — the land might be used for agriculture or young trees might be sold as poles to obtain an immediate income instead of delaying felling until they reached sawlog size. There is a cost to society of the opportunities foregone whenever present consumption is put off for the sake of future benefits. Furthermore, forest capital is not homogeneous. Some forms are irreplaceable, such as tropical rain forest supporting complex ecosystems which have taken thousands of years to develop; replanting after felling cannot fully compensate for loss of the forest as a source of biodiversity, although forest capital will be built up in the new tree crop. Artificial capital is therefore an inadequate and imperfect substitute for forest capital.

The fact that different forms of capital goods are not freely interchangeable has serious implications for development policy and the important debate about environmental safeguards which lies at the heart of concerns about sustainability. In Box 4.12 Pearce, Markandya & Barbier[22] identified three key issues: (i) valuing the environment to take account of quality changes, (ii) extending the time horizon, and (iii) meeting the needs of the least advantaged in society ('intragenerational equity') and fair treatment for future generations ('intergenerational equity'). All three are particularly relevant to changes in national endowments of forest capital.

Box 4.12 Intergenerational equity and sustainability

"These three concepts of environment, futurity and equity are integrated in sustainable development through a general underlying theme. This theme is that *future generations should be compensated for reductions in the endowments of resources brought about by the actions of present generations*.

The underlying logic of this proposition is in fact very simple. If one generation leaves the next generation with less wealth then it has made the future worse off. But sustainable development is about making people better off. Hence a policy which leaves more wealth for future development."

Source: Pearce, Markandya & Barbier (1989), pages 2–3.

Until recently, it was assumed by many economists that it was acceptable to degrade natural environments if man-made capital wealth was provided in lieu. This view is no longer tenable. The conversion of forest capital into artificial capital is likely to deprive future generations of a range of tangible and intangible benefits which artificial capital cannot provide. This is most evident in tropical forests, where destruction and progressive deterioration is taking place at a rapid rate. These losses are irreversible and, clearly, will leave our descendents worse off. In very many places the natural forest capital accumulated over centuries is being dissipated in order to provide subsistence for poor farmers and no compensating investment is taking place outside the forest sector, but even where some development capital does result, the conversion fails the intergenerational equity test of sustainable development.

4.5 TRADE

Forest sector activities generate a substantial amount of trade between countries. Trade flows consist of imports and exports of goods and services; the exports of one country become the imports of others. Inputs of machines, technology and skills, which are not available from local sources, are imported to sustain the sector's productive functions. Outputs of timber and other forest products are exported to foreign countries for either consumption or further processing. Countries which are deficient in forest resources are obliged to meet their needs by importing from elsewhere. Other countries may possess forests, but for a variety of reasons lack the processing and manufacturing capacity necessary to use them fully, so import the finished products that they cannot make. Many countries are both importers and exporters, bringing in roundwood or raw materials from forests in other countries for further processing, and sending out manufactured products for sale abroad. The great natural diversity of forests and variety of different outputs derived from them enhance the possibilities of trade and make it impossible for any nation to be completely self sufficient. Generally, trade widens the range of forest products available to consumers and is therefore beneficial.

The pattern of trade in the forest sector is very complex due to variations in the forest resource endowments of countries, their differences in climate, topography and ecosystem distribution, and the uneven distribution of manufacturing facilities throughout the world. Some countries are heavily dependent on exports of forest products to provide foreign currency for general development purposes, others rely on imports to generate value added and employment for their own populations from the raw materials or semi-processed goods supplied by other nations. To the extent that international trade is not inhibited by tariffs, embargoes or other restrictions, it flourishes on diversity of outputs and the comparative advantages that countries possess for growing, processing and transporting different forest products.

As time passes, changes in the availability of forest products affect prices and consumer preferences, and the resulting market changes affect future production and trade flows. The pattern of trade evolves as countries develop at different

speeds and in different ways; it is also influenced by social differences, power politics and economic forces which have little regard for the welfare of the forest sector. Over the years, forest sector trade has expanded remarkably — total exports of wood products more than doubled in value between 1973 and 1983, and more than doubled again in the following decade. However this growth in trade disguises substantial variations in the quantity and value of its various components and also changes in its direction. As world trading conditions alter, the pattern of trade continues to adapt and develop.

About 3 percent of world trade is attributable to forest products; the forest sector's share of trade is similar in both the developing and developed countries. As can be seen in Table 4.2, the percentage varies slightly between continents, North/Central America being highest with 5 percent, while Africa and Asia derive only two percent of their trade from forest resources. The FAO statistics show that individual countries differ much more widely, ranging from a negligible amount in the drier parts of Africa and Asia up to 63 percent in the Solomon Islands[10]. The share is highest in those tropical countries which are rich in forest resources, rely heavily on log exports and have poorly developed processing facilities, as in the Solomon Islands, Myanmar (50%), Equatorial Guinea (48%) and Laos (41%). The developed countries generally have more diversified economies and the forest sector's contribution tends to be lower. Forest-rich countries again head the list, but those at the top all have sophisticated forest industries which provide substantial exports of processed wood. Finland derived 32 percent of its trade from the forest sector in 1993, followed by Sweden (15%) and Canada (13%); these countries were also the three largest exporters of paper and paperboard in the world.

The developed countries accounted for about four fifths of world trade in forest products in 1993; 80 percent of exports came from them and 79 percent of imports went to them, by value. They continue to dominate as Table 4.3 shows. The most important single country remains the USA, which was the leading importer

Table 4.3 Major importers and exporters of forest products in 1997 and 2001

Country	Value of imports *(million $)*		Value of exports *(million $)*	
	1997	2001	1997	2001
USA	24 134	24 026	16 334	14065
China	12 656	14 571	3 746	3 698
Canada	3 976	3 866	25 648	24 317
Japan	16 684	11 194	1 640	1 593
Germany	10 916	11 311	9 828	10 538
United Kingdom	9 993	8, 938	2 124	2 022
Finland	716	976	10 414	10 093
Indonesia	976	1 030	5 115	4 994

Source: FAO. Forest Products Yearbook, 2001.

and ranked second as an exporter of forest products, after Canada. A significant share of the world trade in forest products is therefore centred on North America and much of this is concerned with coniferous timber. Trade in forest products is regionalized within three important trading blocs — North America, the Pacific Rim and Western Europe[23]. Much of the trade between European countries consists of manufactured products. Indonesia, Malaysia, New Zealand and Chile are major exporters, providing roundwood, sawnwood and panels to Japan, Korea, China and Singapore. Indonesia is a leading supplier of plywood and Malaysia is a large exporter of veneer sheets. Imports by China have more than doubled since 1993.

More detailed analysis of the data for 2001 provides a breakdown of the production and export statistics into their components by quantity. The largest components of production consisted of outputs before processing took place, with its accompanying loss of bulk on conversion. Table 4.4 shows the proportion of production that was exported for each of the main products derived from wood. In its natural state, either as roundwood or roughly squared, timber is relatively low in value, bulky and costly to transport. Consequently, nearly all fuelwood is used locally and very little is exported. The proportion of industrial roundwood (including logs, pulpwood and woodchips) that enters international trade is also quite low. After processing, the value to weight ratio is higher and the percentage

Table 4.4 World production and exports of forest products in 2001, and proportions entering trade

Product	Quantity produced 2001 *million units*[1]	Quantity exported 2001 *million units*[1]	Proportions entering trade[2]	
			2001 %	1973 %
Wood Fuel	1, 784	4	0.2	0.2
Industrial roundwood	1, 543	117	7.6	8.4
Sawnwood + sleepers	378	110	29.1	16.4
Coniferous	271			
Non-coniferous	106			
Wood-based panels	181	60	33.1	15.2
Veneer sheets	7			
Plywood	56			
Particle board	83			
Fibreboard	34			
Wood pulp	166	38	22.9	16.2
Paper + paperboard	320	95	29.7	18.6
Newsprint	39			
Printing + writing paper	95			
Other paper + paperboard	187			

Notes:
[1] Unit = 1 cubic metre of fuelwood, roundwood, sawnwood or panels, or 1 metric ton of pulp or paper.
[2] Exports as a percentage of production in 2001 and 1973.
Sources: based on statistics from FAO's Forest Products Yearbook, 1983–1994 and Forest Products Yearbook, 2001.

that is exported increases significantly. As with value added and employment, so also with international trade; activities at the beginning of the processing chain contribute relatively little compared with the amount of trade generated by subsequent subsectors. Most of the exports and imports of the forest sector are the result of its manufacturing activities and the proportion traded increases with the degree of processing.

In general, except for industrial roundwood, production has expanded in all categories since 1973 and there have been significant changes in the proportions exported as Table 4.4 reveals. The proportion exported was higher in 2001 than in 1973 except for industrial roundwood. This was largely due to efforts by the developing countries to reduce their roundwood exports and encourage domestic processing. Production of non-coniferous sawlogs + veneer logs from developing countries increased by 72 percent while exports fell from 50 to less than 20 million cubic metres between 1973 and 1993. Within the 'wood-based panels' group, instead of exporting their veneers, countries have tended to use them locally in the manufacture of plywood and other types of panel.

World exports of wood products increased in value almost 4½ times, from $22.4 billion in 1973 to $99.5 billion in 1993, and since then by more than a quarter. All groups of products showed export value increases between 1993 and 2001, except for wood fuel and industrial roundwood. As can be seen in Table 4.5, the smallest

Table 4.5 World exports of forest products in 1993 and 2001, and composition by value

Product	Value of exports 1993 *million $, f.o.b.*	Value of exports 2001 *million $, f.o.b.*	Composition by value[1]	
			1993 %	2001 %
Fuelwood + charcoal	224	85	0.2	0.1
Industrial roundwood	9,878	7,958	9.9	6.2
Sawnwood + sleepers	21,292	21,721	21.4	17.0
Coniferous	15,102	15,422	15.2	12.1
Non-coniferous	6,190	6,299	6.2	4.9
Wood-based panels	13,149	16,352	13.2	12.8
Veneer sheets	1,537	2,572	1.5	2.0
Plywood	8,009	6,474	8.0	5.1
Particle board	2,237	3,929	2.2	3.1
Fibreboard	1,365	3,378	1.4	2.6
Wood pulp	10,996	16,081	11.1	12.6
Paper + paperboard	43,728	65,707	44.0	51.4
Newsprint	8,163	9,332	8.2	7.3
Printing + writing paper	16,822	28,582	16.9	22.3
Other paper + paperboard	18,743	27,793	18.8	21.7
TOTAL	99,492	127,904	100	100

Notes:
[1]Composition as a percentage of total value of exports.
Sources: based on statistics from FAO's Forest Products Yearbook, 1983–1994 and Forest Products Yearbook, 2001

gain was in sawnwood and the biggest increase was in paper and paper board products. Exports of products which involved less processing and used methods which were less capital intensive tended to increase at a slower rate than more sophisticated products further down the processing chain.

The most significant factor in forest sector trade is the extent of processing activities that takes place. This is evident from the statistics of quantities exported, but is also born out by the data on the composition by value in Table 4.5. A negligible amount comes from fuelwood and the largest contribution is made by paper and paper board manufacturing, which accounted for 44 percent of the total value of exports in 1993 and 51 percent in 2001. Value tends to be concentrated in the later stages of processing.

While trade expanded, changes in its composition have also occurred. The concentration of value in the more sophisticated products has been accentuated with the passage of time. Between 1973 and 1993, the proportion of total exports provided by industrial roundwood decreased from 17.8 to 9.9 percent; by 2001 it had fallen to 6.2 percent. The contribution from sawnwood fell from 25.3 to 21.4 percent and subsequently to 17 percent over the same time periods. Conversely, the contribution from the more highly processed products has increased.

The stage of development of forest-based industries in particular countries has a more potent influence on their trade than their endowment with forest resources. Some countries have extensive forests but little in the way of industries and negligible exports, while others have used their forest resources to build up large-scale industries which contribute substantial export flows. For example, Guyana has 15.1 million ha of forest (76.7% of its land area) but exports forest products worth only a fraction of those provided by Finland, with a similar percentage of forest (73.9), which produced exports worth $10 billion in 2001. More than 70 percent of Finland's exports consisted of paper and paperboard. Forest resources, used as a basis for industrialisation, can generate substantial export benefits. Malaysia, with a comparable area of tropical forest (20.9 million ha) to Guyana, produced exports worth $4.3 billion in 1993, of which 31 percent consisted of panels and 41 percent was sawnwood.

There are also some 'transit processors', notably Singapore and Hong Kong, which have no forest resources of their own, but have developed wood-based industries using imported raw materials. A large part of the output of these industries is then exported. Singapore imported forest products worth $779 million in 1993; domestic production was valued at $204 million and exports at $442 million. However, the considerable quantity of sawnwood and plywood manufactured there is declining as hardwood log supplies are restricted by exporting countries in the region, which seek to create value added and employment for themselves rather than allow these benefits to pass to foreigners. Indonesia, for example, imposed a log export ban on 1st January 1985 to protect its rapidly expanding plywood industry. These restrictions have also affected South Korea, Taiwan and Japan, forcing them to search for alternative supplies of logs.

Protectionism and trade interventions of various different kinds are commonplace. They do not always achieve their purpose and usually tend to restrict the flow of trade. The general view of economists is that international trade has a beneficial effect on economic development. Free trade and expanding markets enable countries to specialize in the production of those goods in which they have a comparative advantage and, in theory, all countries would be better off if trade could be liberalized. However, even if this is the best policy for the world as a whole, it may not be in the interests of particular countries or individual producers of specific commodities. Supporters of restrictions argue that they can be used to improve the terms of trade for importers, increase employment by substituting domestic production for imports, encourage industrialization by protecting 'infant industries', generate revenue for governments and improve the balance of payments[24]. In practice, national interests often prevail over wider economic welfare considerations; trade barriers are a fact of life.

Any government law, policy or practice which is intended to restrict trade is described as a trade barrier. Two categories are usually distinguished: tariff and non-tariff measures. Tariffs are relatively straightforward charges on imports, which have the effect of putting a tax on other countries' exports, thus raising their prices compared with domestically produced goods. Non-tariff measures are diverse, and sometimes difficult to identify and measure; they include quotas, prohibitions and licencing of imports, and a variety of export controls, duties and taxes. The effect of these barriers is to reduce the volume and influence the pattern of trade. International efforts to reduce the barriers have focussed on the series of multilateral negotiations conducted under the auspices of the General Agreement on Tariffs and Trade (GATT). Significant reductions in tariffs resulted from the Tokyo Round of negotiations, which was completed in 1979, and the Uruguay Round, finalized in April 1994, led to further substantial lowering.

International trade in forest products has benefited from these negotiations. The extent of the tariff reductions which were achieved differed according to the markets and the products. In a study of the effects of the Tokyo Round, tariff rates for wood and wood products in major developed country markets, were estimated to be zero for wood in the rough; to have declined from 2.4 percent (pre-Tokyo Round) to 1.7 percent (post-Tokyo Round) for primary wood products, and to have been reduced from 7.8 to 5.7 percent for secondary products (UNIDO, 1983). Rates in most developed countries had reached very low levels even before the Uruguay Round. Imports of forest products from all sources, valued at $40.6 billion, were subject to a pre-Uruguay Round average tariff rate of 3.5 percent, falling to 1.1 percent post-Uruguay Round[25]. Tariff rates in developing countries are generally higher, often substantially higher, compared with rates in developed countries.

An important feature is known as *tariff escalation*, which is common in agricultural and forest products. This is the extent to which rates rise with the level of processing and value added; lowest on unprocessed products and rising with increased processing. Low or zero rates on wood in the rough, higher rates on

Box 4.13 New barriers to forest products trade

"In recent years there has been a proliferation of additional policies and regulations that have the potential of becoming 'new' barriers to the forest products trade. These barriers include:

- export restrictions by developing countries to encourage domestic processing of tropical timber for export;
- environmental and trade restrictions on production and exports in developed countries that affect international trade patterns;
- quantitative restrictions on imports of 'unsustainably produced' timber products;
- the use of ecolabelling and 'green' certification as import barriers.

Although only the last two measures could be strictly defined as new, all of these trade measures have been increasingly employed in recent years and have the potential to affect forest product trade flows significantly."

Source: Barbier (1995), page 9.

sawn timber and panels, and even higher rates on secondary products such as furniture are found in the forest sector. Tariff escalation has an adverse effect on exports of processed products from developing countries and inhibits their efforts to promote further processing in the forest sector. The Uruguay Round has reduced significantly the degree of escalation faced by forest products in developed country markets; the reduction on panels was 30 percent, on semi-manufactures 50 percent and on manufactured articles 67 percent, while on pulp and paper products it was eliminated completely.

Trade interventions by exporting countries include various taxes or levies on exports as well as log export bans and other quantitative and qualitative controls applied to specific products or species. In the past, export taxes on wood in the rough were used in many tropical countries as a way of raising revenue. Taxes and bans are now increasingly used for strategic purposes, such as the encouragement of forest-based industrialization and attempts by the larger exporters, particularly Malaysia and Indonesia, to capture a large share of the international market for tropical timber. At first, the tendency was to levy export taxes at descending rates: typically rates on logs ranged between 10 and 20 percent, rates on sawn timber were half those on logs, while rates on veneer and plywood were negligible. This export tax structure was designed to promote the development of forest industries and is still being used in some countries. However, export taxes have now been replaced by bans in many tropical countries[26]. It has also become clear that, even though export restrictions may have been successful in stimulating growth and employment, they have also led to overcapacity and inefficiency in forest industries.

Environmental issues are beginning to have an effect on trade as noted in Box 4.13. Producer countries may impose restrictions on forest exploitation to

preserve particular species of wildlife, ecosystems or areas of outstanding natural beauty. These restrictions have knock-on effects on the levels of harvesting and processing activities, and quantities, prices and trade in forest products. Trade may also be curtailed by the introduction of sustainable levels of harvesting where resources are at present being overcut and depleted. Global warming has become a major concern which encourages forest protection and stimulates afforestation. Bans by importing countries on tropical timber have been suggested with the aim of arresting tropical deforestation, even though they are very unlikely to be effective. Exporting industries in developed countries may be more tightly controlled to reduce water and air pollution, putting up their costs and prices, and possibly driving them out to other countries where standards are less demanding. The possibility of using trade barriers to try to alter the behaviour of countries that ignore standards of behaviour set by the global community on environmental matters, has now become an issue that can lead to international tension and disputes.

SUMMARY

- A variety of activities take place in the forest sector; some are forest-based and concerned directly with the protection and management of forest resources, others are focussed on the transformation and movement of forest products after they leave the forest en route to consumers. The *forestry* activities are 'supply' oriented, while the *industrial* activities are 'demand' or consumer oriented.
- A comprehensive view of the sector is obtained by dividing it into six subsectors based on the different kinds of activity involved in wood production: forest management, harvesting, primary processing, secondary manufacturing, construction, and distribution & trade. Some types of product do not involve all subsectors and service outputs accrue directly to end-users.
- The subsectors form a sequence, following the direction of flow of raw materials and outputs, from subsector to subsector along the processing chain. Different technologies, time horizons and types of enterprise or agency are involved at each stage.
- Value is added to forest products as they move along the processing chain. The total value added by the forest sector is its contribution to the gross domestic product (GDP); it is made up of the sum of its final outputs less the value of inputs derived from other sectors. It is necessary to make adjustments for stock changes. Alternatively, value added represents the sum available for payment of wages and salaries, interest, profits, taxes and depreciation.
- Value added builds up along the processing chain; the later subsectors contribute much more than the earlier ones.
- Forest sector activities generate incomes and provide employment. Employment also expands along the processing chain.
- The sector contributes to capital formation by investment; *artificial* capital is man-made, in the form of buildings, machines, vehicles and equipment, while *natural* capital is derived from nature and owes its value to the uses to which

it is put. *Forest* capital consists of the capital found in forests, including their ecosystems and the trees, plants, wildlife and other living organisms that live in the forest, which may be augmented artificially by forest management and tree planting activities.

- International trade results from forest sector activities. About three percent of world trade is attributable to forest products; the developed countries account for four fifths of this trade. Most of the exports and imports of wood products are the result of manufacturing. World exports increased almost $4\frac{1}{2}$ times in value between 1973 and 1993 and since then by more than a quarter, the more highly processed products showing the fastest increase. Trade in forest products has benefitted from tariff reductions resulting from negotiations conducted during the Tokyo and Uruguay Rounds.

FURTHER READING

Hair's classic study of *The Economic Importance of Timber in the United States*, published in 1963 by the U.S. Forest Service (Miscellaneous Publication 941), provided the first full analysis of sectoral activities based on timber, with their contribution to value added and employment along the processing chain. A later report showed comparative figures for 1963, 1967 and 1972 (USDA Forest Service General Technical Report WO-21, 1980).

The treatment of natural resources in national accounts is dealt with by Repetto et al. Their contribution entitled *Wasting Assets: Natural Resources in the National Income Accounts* has been reproduced as Chap. 25 in *Environmental Economics*, edited by Markandya & Richardson, Earthscan, 1992.

An important source of statistics is the UN Food & Agriculture Organization. *Forestry Statistics Today for Tomorrow: 1945–1993.....2010* which gives output data by countries. The *Global Forest Resources Assessment 2005* provides upto figures or removales from the forest. Production and trade figures are produced annually in the Yearbooks of Forest Products.

Westoby's important contribution *The Role of Forest Industries in the Attack on Underdevelopment*, was published by FAO in 1962. It is available, and was given a fresh perspective, in the collection of his writings published by Blackwell in 1987, entitled *The Purpose of Forests*.

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